Multi-Spectral Satellite Imagery and Land Surface Modeling Supporting Dust Detection and Forecasting

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SPoRT-NWS Collaboration

The NASA Short-term Prediction Research and Transition (SPoRT) Center integrates unique NASA satellite and weather forecast modeling capabilities into the weather forecasting community (Figure 1).

Figure 1. Current map of SPoRT partners, including data sources, end-user forecast offices, NOAA/NWS National Centers, and product development partnerships.

Multi-Spectral False Color Composites

- The SPoRT Center has developed multi-spectral, false color composites to help identify lofted dust, based upon recipes from EUMETSAT.
- Products can be derived from multi-spectral instruments such as NASA's Terra and Aqua MODIS, the VIIRS aboard the Suomi-NPP satellite, the recently launched Himawari, and upcoming GOES-R series (Table 1)

Color Input	Bands Used	Physical Property
Red	12.0-10.8 µm	Optical Thickness
Green	10.8-8.7 µm	Particle Phase
Blue	10.8 µm	Temperature

Table 1. Selected bands and paired band differences comprising the multi-spectral dust product developed by EUMETSAT and produced by SPoRT.

- In the false color composite, specific shades of pinks and purples correspond to dust.
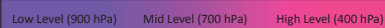- Specific colors depend upon atmospheric characteristics but dust is easily observed.

Low Level (900 hPa)	Mid Level (700 hPa)	High Level (400 hPa)

Figure 2. Colors often associated with blowing dust.

Imagery Examples and Use Case Scenarios

- Large synoptic-scale cyclones are often associated with strong winds, which can kick up large areas of low to mid-level dust in the central United States. Dust limits visibility, health issues, and other problems.
- Figure 3 shows an example of dust observed by VIIRS following the passage of a strong cold front through southeastern Colorado.
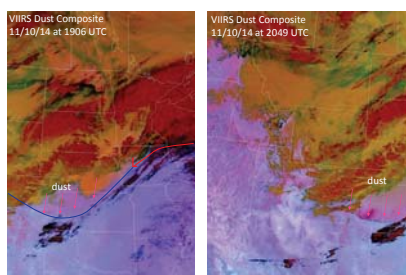

Figure 3. Examples of blowing dust as observed by the VIIRS instrument on November 10, 2014.

- Products are provided to NOAA/National Weather Service partners for use in their decision support systems, alongside other data.
- Dust imagery (Figure 4) can be used to issue public weather advisories that alert the population to dust as a visibility and transportation hazard, or health impacts.
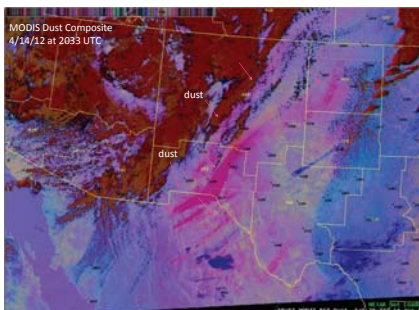

Figure 4. MODIS dust imagery used by NWS Albuquerque, NM to observe dust and issue appropriate advisories.

Land Surface Modeling for Dust Source Regions

- Blowing dust events are often associated with low soil moisture or sparse vegetation, which provides dry, unprotected material to be lofted by strong winds.
- The SPoRT Center uses the NASA Land Information System (LIS) to simulate soil moisture conditions by using available radar and satellite precipitation data sets, and NWP guidance for forcing.
- Figure 5 shows dry conditions for southeastern Colorado during the post-frontal dust event in Figure 4.
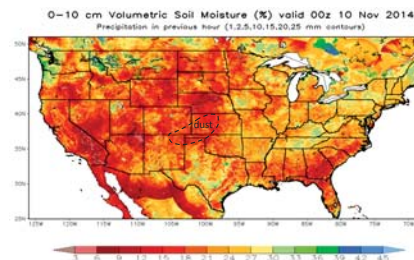

Figure 5. Map of 0-10 cm (top soil layer) volumetric soil moisture across the United States on 10 November 2014.

- Sparse vegetation can also lead to blowing dust events, especially in agricultural regions where vegetation coverage has a strong seasonal cycle.
- The SPoRT Center uses vegetation indices from Terra, Aqua MODIS, and S-NPP VIIRS to determine a green vegetation fraction across the LIS domain.
- Figure 6 highlights sparse vegetation across Colorado and Kansas that contributed to the blowing dust event.
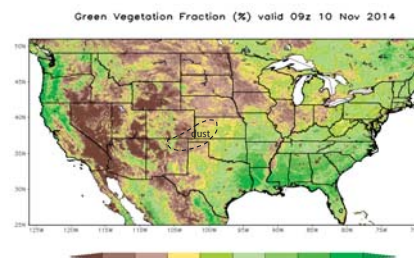

Figure 6. Green vegetation fraction across the continental United States on 10 November 2014.

LIS Applications to Drought Monitoring

- Monitoring of soil moisture and vegetation for dust detection and forecasting applications naturally links to monitoring of drought and other extreme events.
- Output from LIS data are often used to adjust inputs to the U.S. Drought Monitor. NWS partners in Huntsville, AL and Raleigh, NC have used LIS data in this way. An example of LIS data applied to drought monitoring for North Carolina is shown in Figure 7.
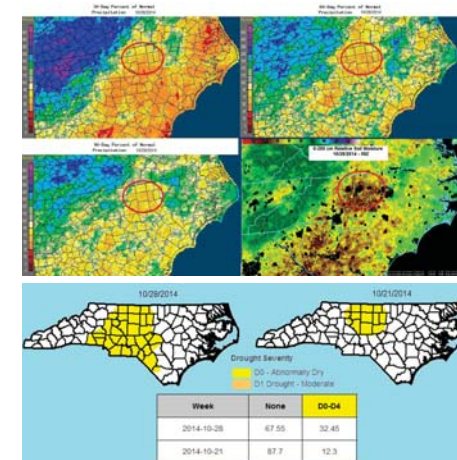

Figure 7. (top) Multi-day rainfall periods acquired from rainfall over North Carolina, and relationship of low rainfall to dry soil moisture conditions. (bottom) Expansion of the drought category across North Carolina from LIS analysis.

Future Work

- Recent launches of NASA's Global Precipitation Measurement (GPM) mission will provide improved, global analyses of rainfall and snowfall for refinement of LIS outputs and expansion to other regions.
- The upcoming launch of the Soil Moisture Active Passive (SMAP) mission will allow for assimilation of soil moisture measurements to improve analyses.
- The SPoRT Center is an "Early Adopter" for both instruments, helping NASA's Applied Sciences Program develop and demonstrate exciting, new applications for both missions.